Blackbody radiation:

<u>Monochromatic</u> irradiance of radiation emitted by a blackbody at (absolute) temperature T is given by:

$$E_\lambda = \frac{C_1}{\lambda_5\left(e^{\left(C_2/\lambda T\right)} - 1\right)}$$

When $C_2 = 3.74 \times 10^{-16} Wm^2$

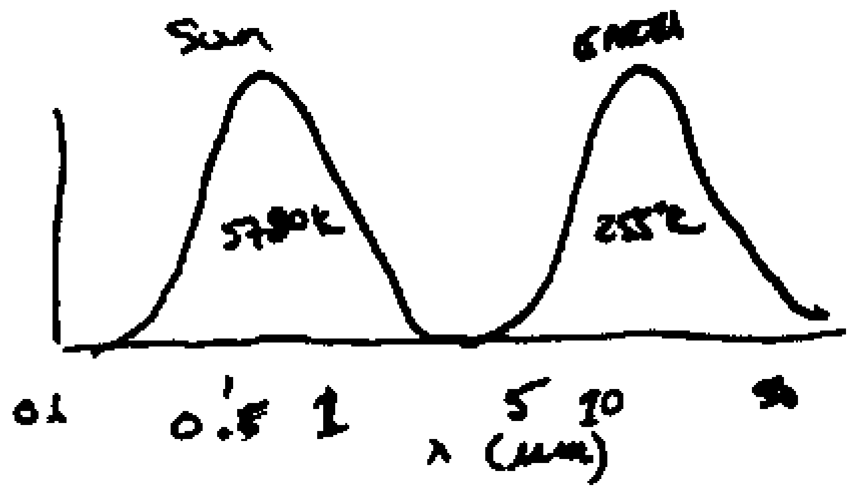
$C_2 = 1.44 \times 10^{-2}\ m^o k$

Blackbody radiation is isotopic

$$E\lambda \cong C_1 \lambda^{-5} e^{(-C2/\lambda T)}$$

$$\lambda m = \frac{2897}{T}$$

<u>Weins Displacement Law</u>



The Maximum wavelength of emission of the Sun is 0.475 μm (475 nm)

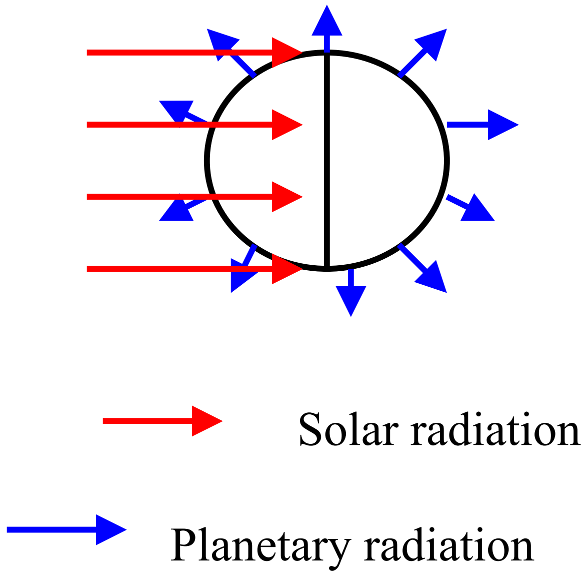
What is the "color temperature" of the sun?

Integrating the Planck blackbody irradiance over all wavelengths

$$E^* = \sigma T^4$$

σ is the Stefan – Boltzman constant

$$5.67 \times 10^{-8} wm^{-2} degree^{-4}$$



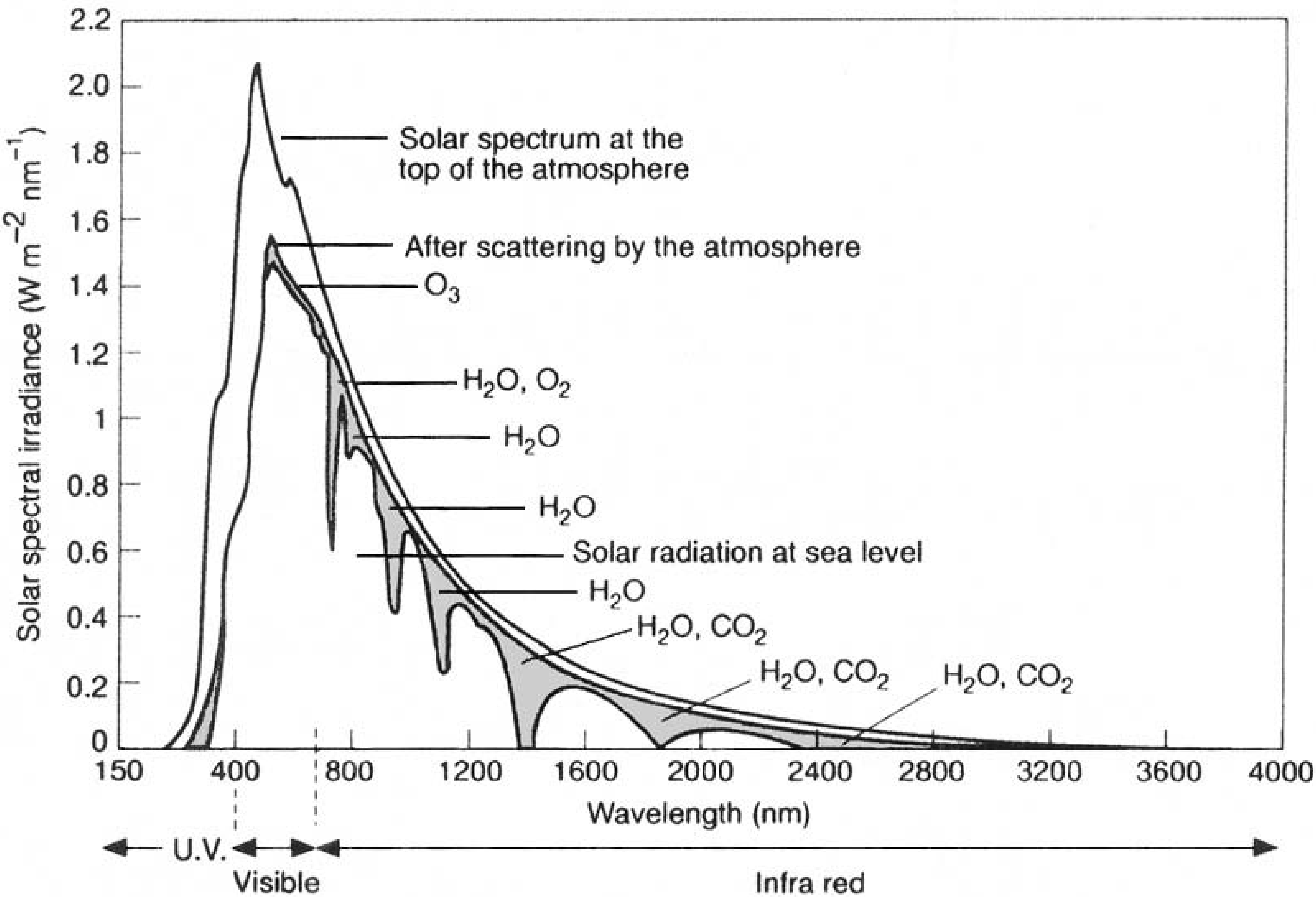
Let S_o be solar irradiance incident on Earth (=1380 wm-2)-the solar “constant”, R_e is the radius of Earth, $\propto$ is alkedo.

At equilibrium, Incoming = Outgoing

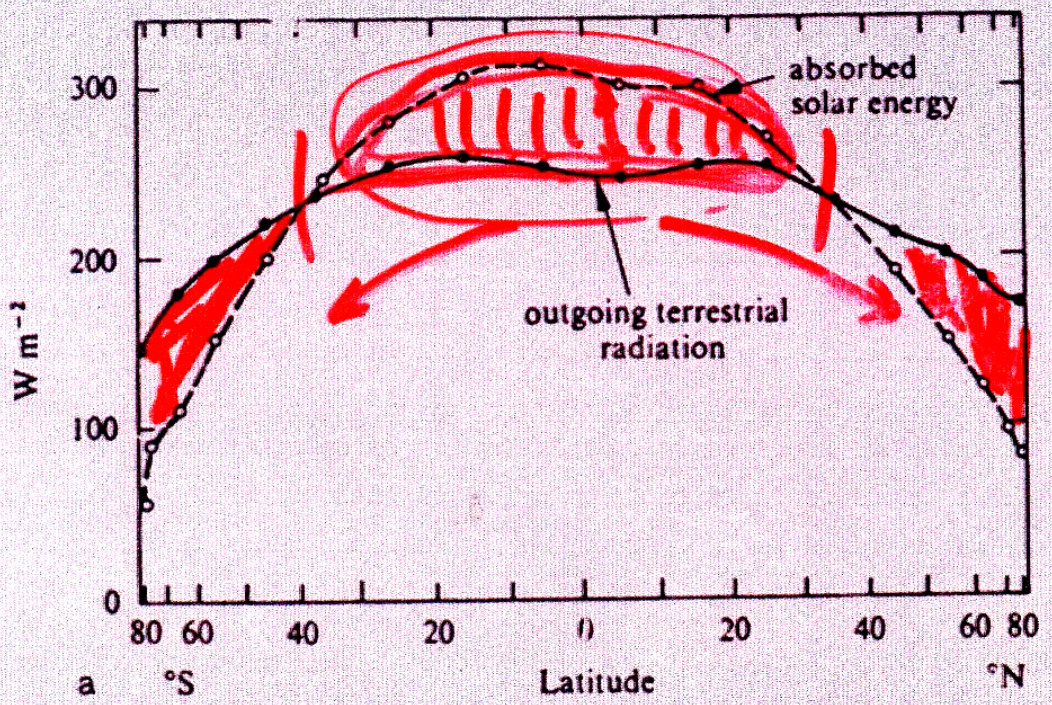
$$(1-\propto)\, S_o \pi\, R_e^2 = E\ \ 4\pi\, R_e^2$$

$$\therefore\ E = S_o/4\ (1-\propto)$$

$$\sigma T^4 = \tfrac{1}{4}\, S_o\, (1-\propto)$$ =key radiant Eqn for climate



Solar spectral irradiance (W m^{-2} nm^{-1})
2.2
2.0
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Solar spectrum at the top of the atmosphere
After scattering by the atmosphere
O_3
H_2O, O_2
H_2O
H_2O
Solar radiation at sea level
H_2O
H_2O, CO_2
H_2O, CO_2
H_2O, CO_2
150
400
800
1200
1600
2000
2400
2800
3200
3600
4000
Wavelength (nm)
U.V.
Visible
Infra red



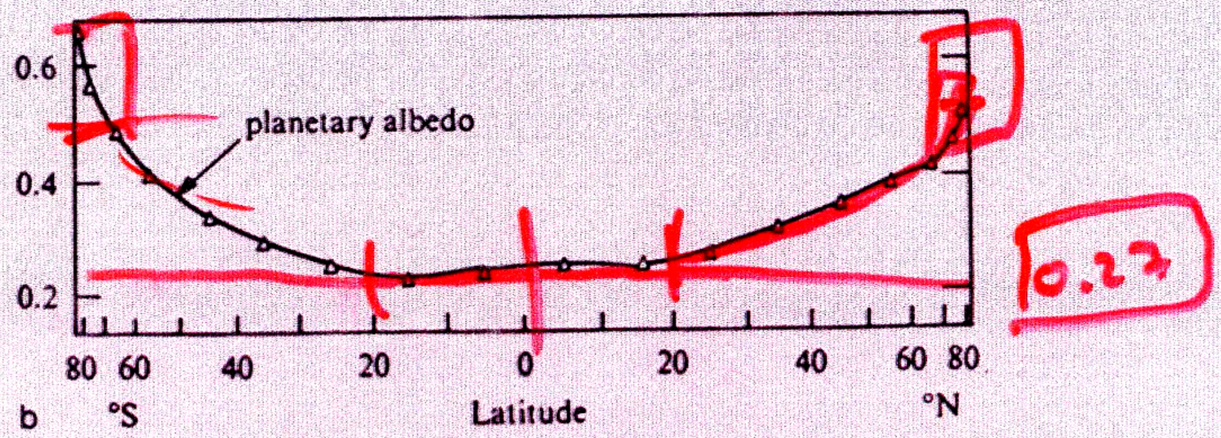
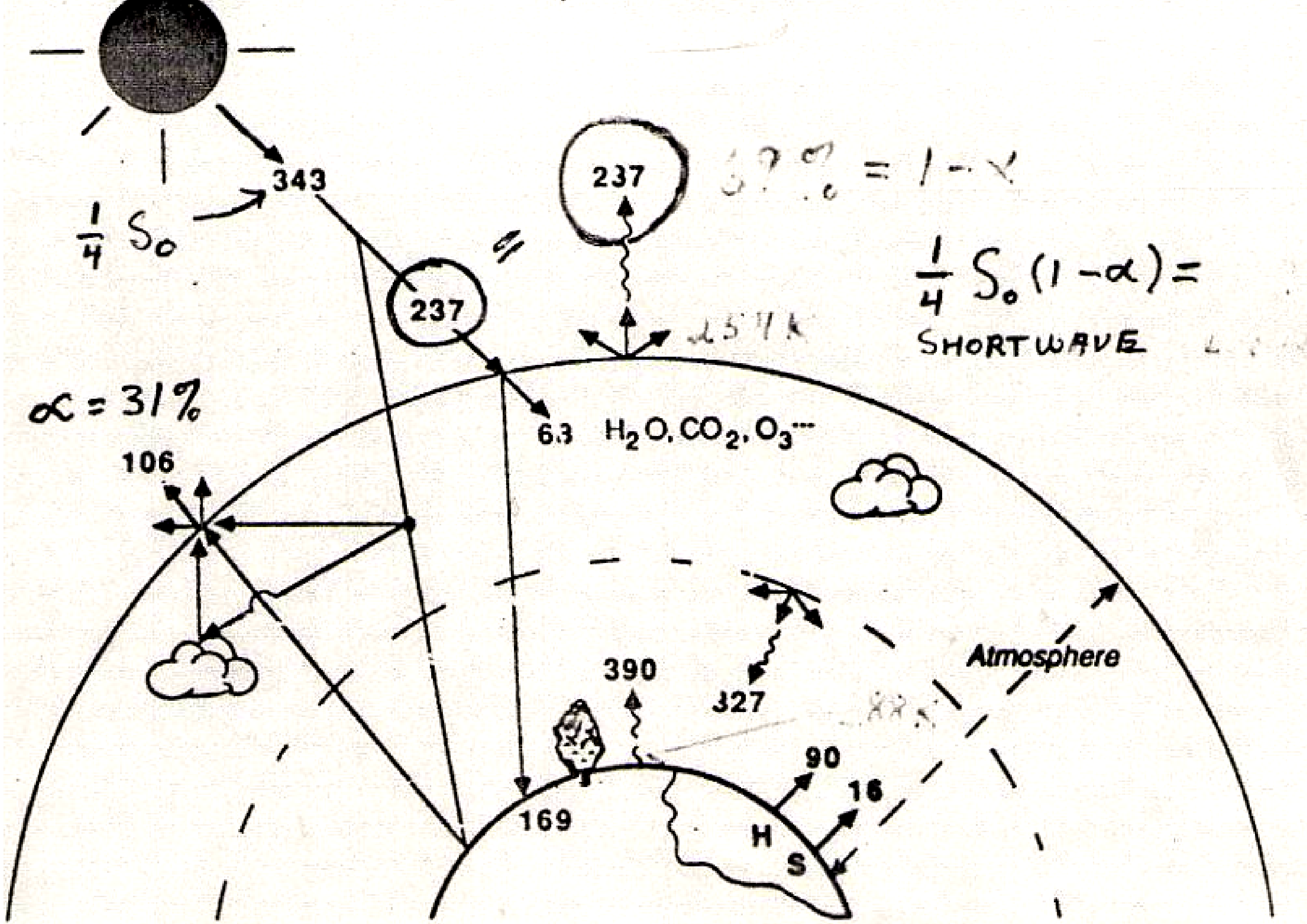


Fig. 5.15. a Solar energy absorbed and terrestrial radiative energy emitted by the earth atmosphere system. **b** Earth's albedo measured by satellite. (Von der Haar and Suomi 1971)

GLOBAL ENERGY BALANCE

(Unit: $W \cdot m^{-2}$)



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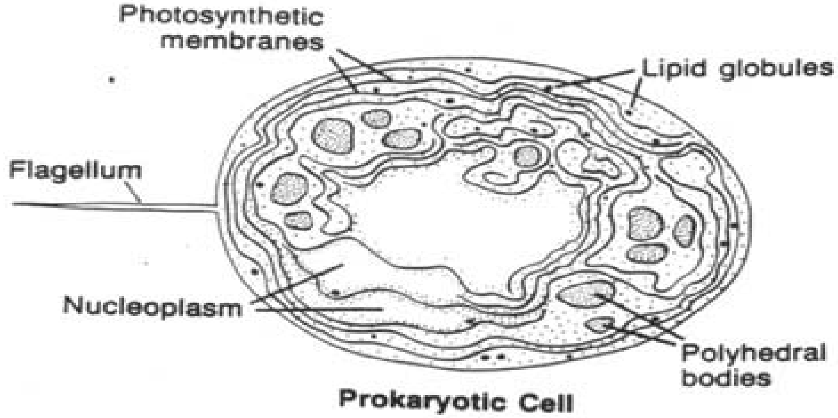
The Role of Earth Radiation Budget Studies in Climate and General Circulation Research



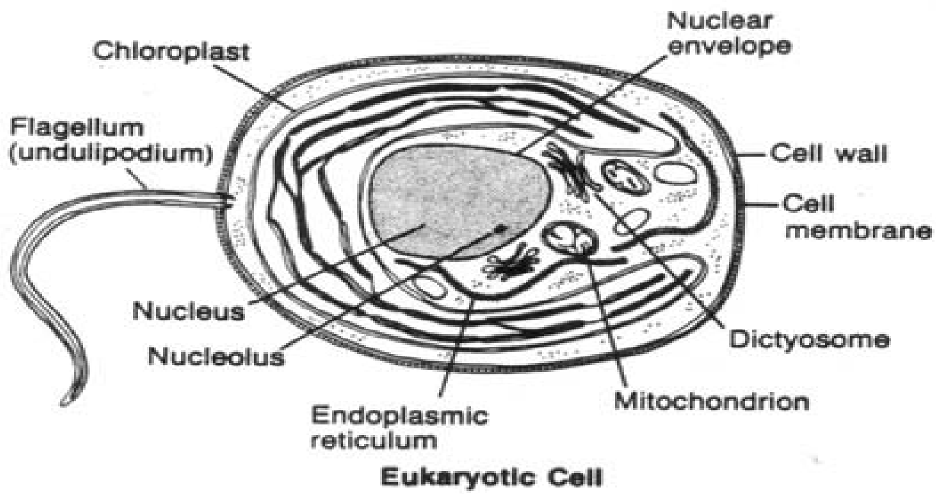


Figure 1.1 Prokaryotic and eukaryotic cells, showing their principal differences (see Table 1.1). The prokaryotic cell lacks a nucleus, chromosomes, mitochondria, and chloroplasts, and generally ranges in size between 0.5 and 15 μm. Eukaryotic cells possess a variety of organelles, one or more nuclei, 2–600 chromosomes, mitochondria, and in some, chloroplasts. They are generally much larger than prokaryotic cells.

Table 1.1 Some primary differences between prokaryotes and eukaryotes (see also Chapter 5)

Prokaryotes	Eukaryotes
Nucleus absent	Nucleus present
Meiosis absent	Meiosis
One basic genome	Chromosome number 2–600
Mitochondria absent	Mitochondria present
Chloroplasts absent	Chloroplasts may be present
Endoplasmic reticulum absent	Endoplasmic reticulum present
Vacuoles absent	Vacuoles present

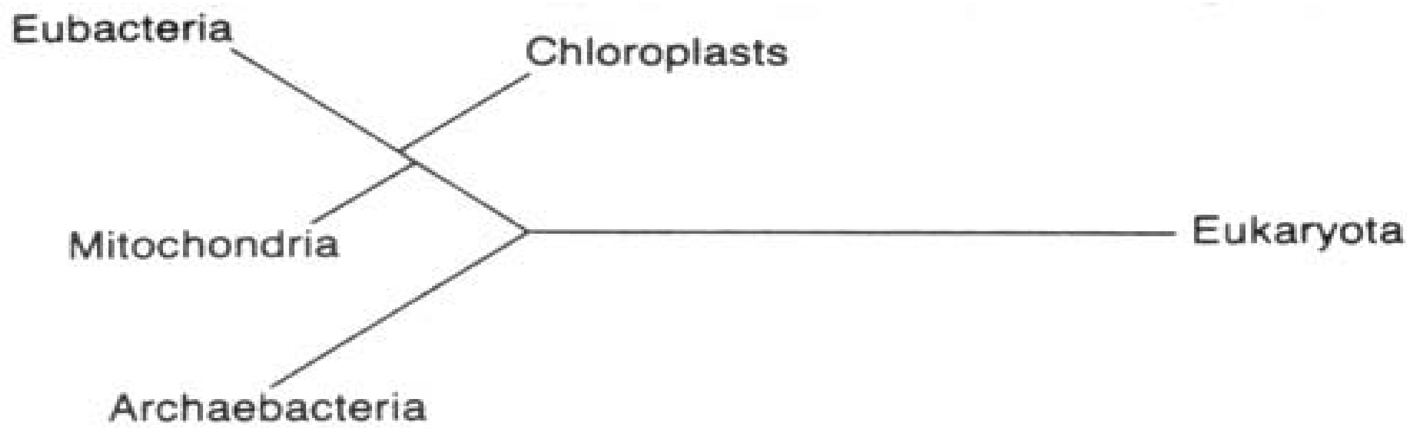
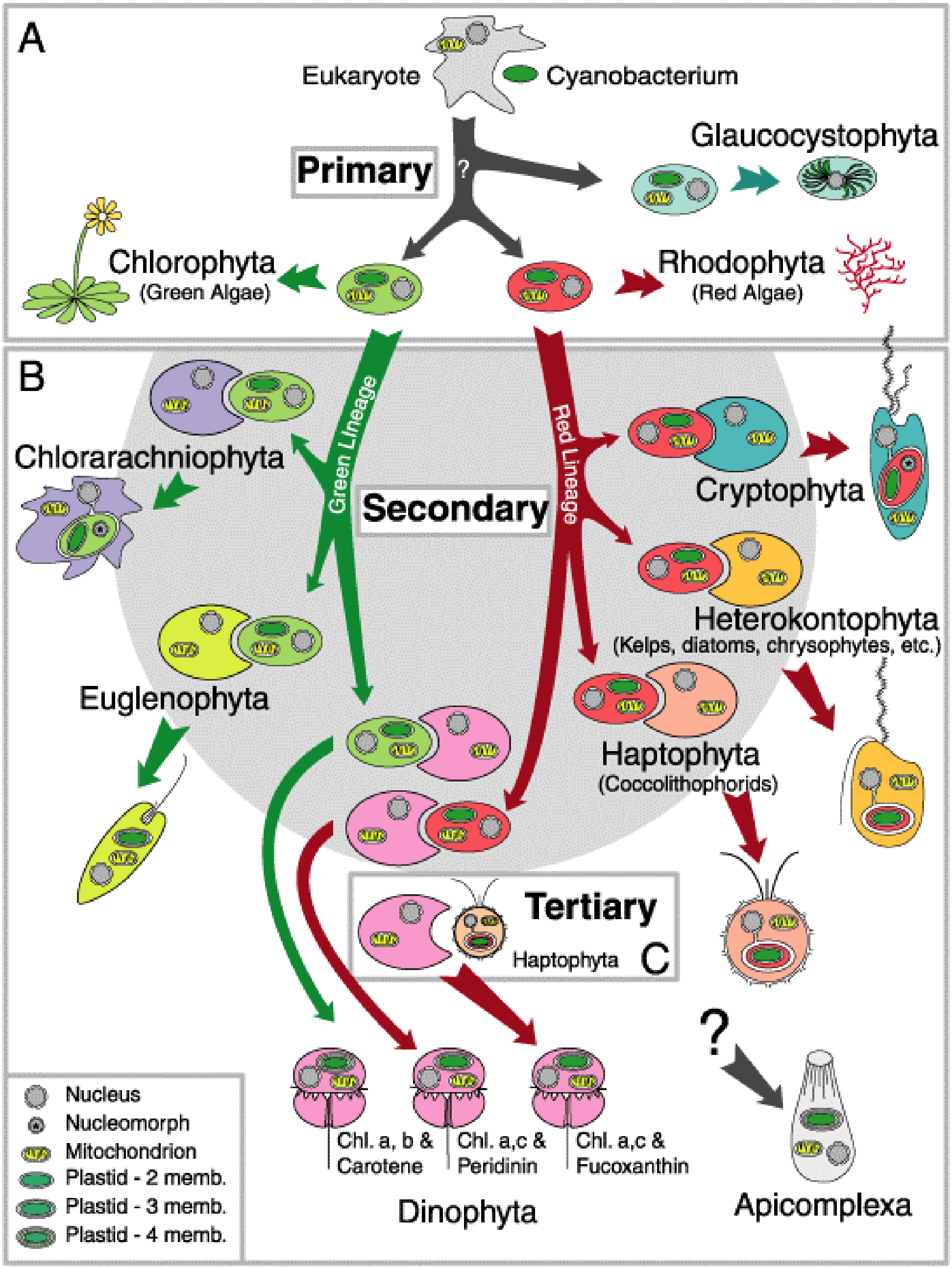


Figure 1.3 RNA phylogeny of life, showing the deep separation between the archaebacteria, eubacteria, and eukaryotes, as well as the close relationship between eukaryotic chloroplasts, mitochondria, and the eubacteria.



Modified from Delwiche, C.F. 1999. Tracing the thread of plastid diversity through the tapestry of life. Am. Nat. 154:S164-S177.

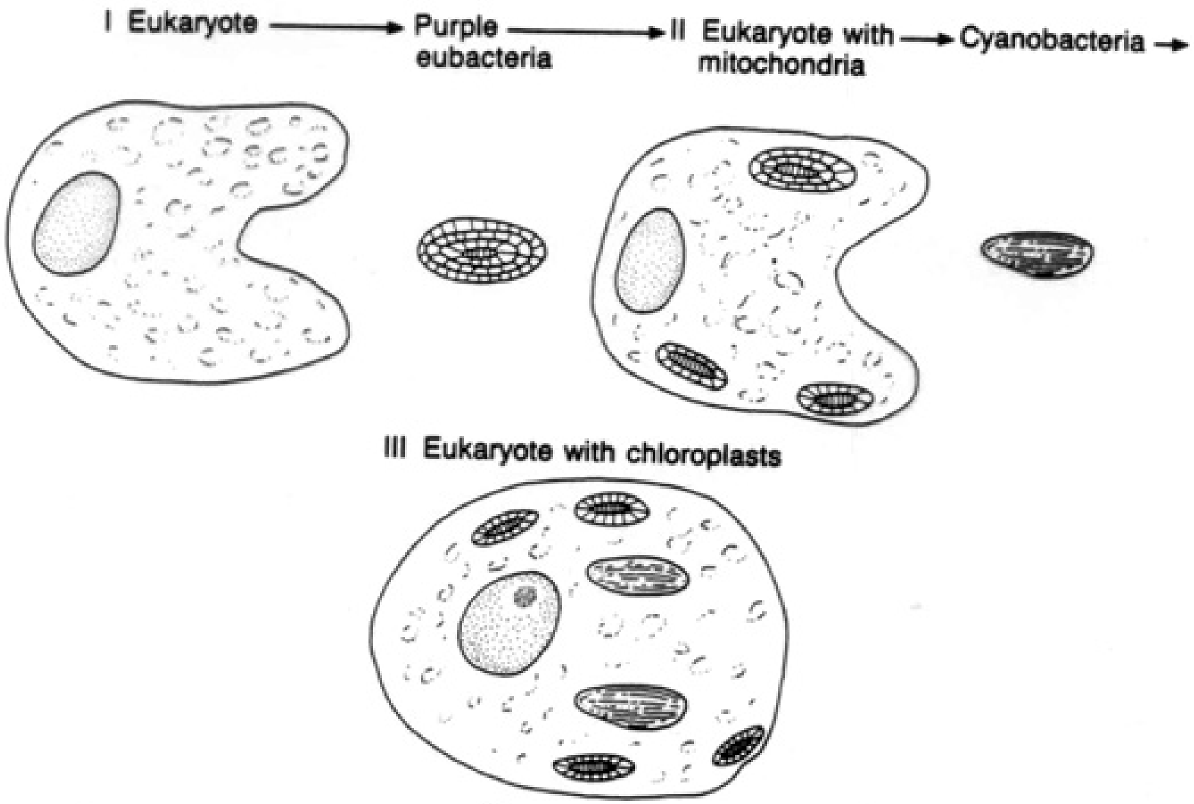
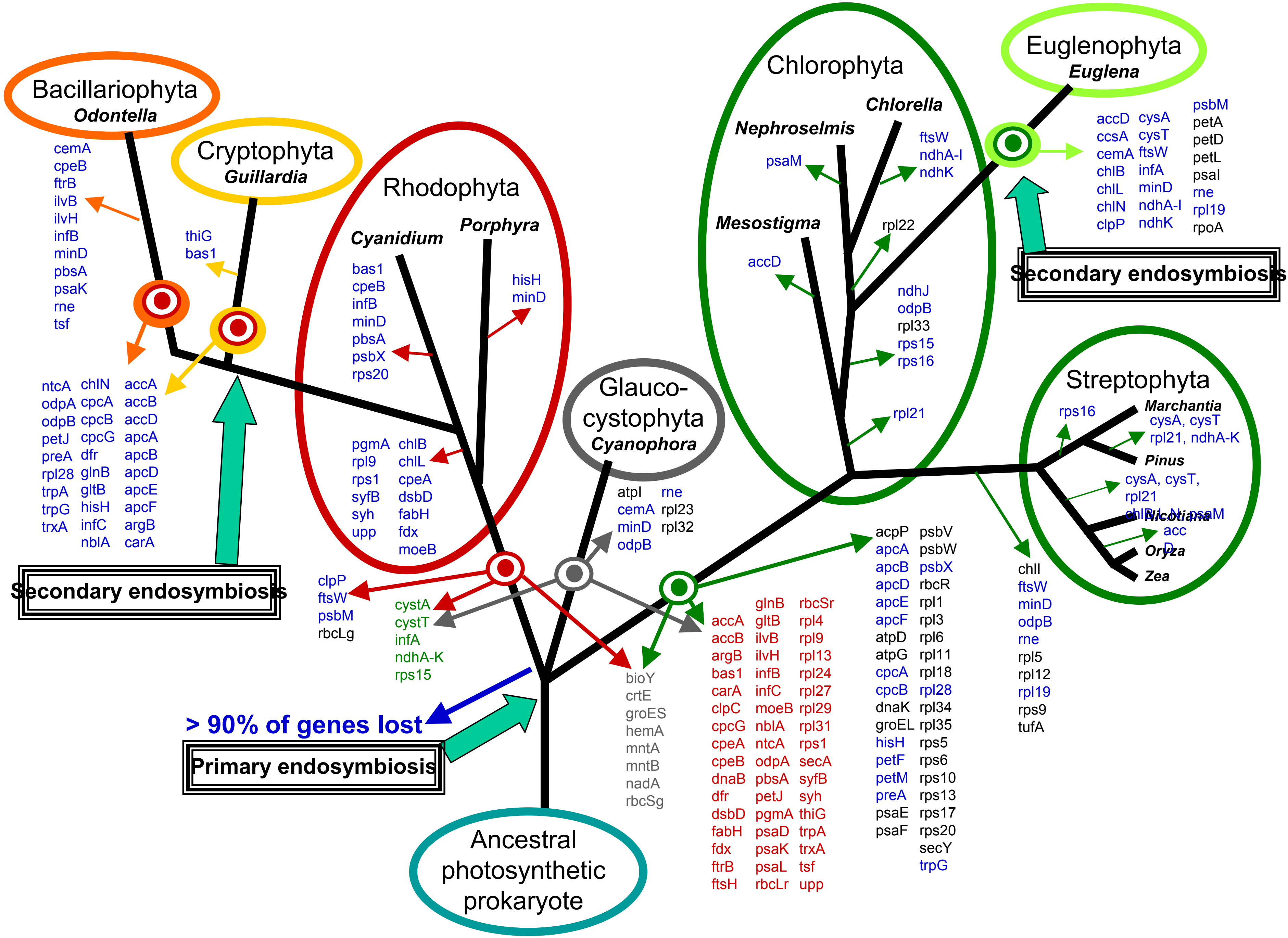


Figure 1.5 Representation of the endosymbiosis theory for the development of the eukaryotic cell. A preexisting eukaryotic lineage with a cell structure and nucleus acquires first a purple bacterium followed by a cyanobacterium as endosymbionts. These transfer genetic material to the nucleus of the cell, thus making an integrated eukaryotic cell.



Bacillariophyta
Odontella
cemA cpeB ftrB ilvB ilvH infB minD pbsA psaK rne tsf
Cryptophyta
Guillardia
thiG bas1
ntcA odpA odpB petJ preA rpl28 trpA trpG trxA
chlN cpcA cpcB cpcG dfr glnB gltB hisH infC nblA
accA accB accD apcA apcB apcD apcE apcF argB carA
Secondary endosymbiosis
Rhodophyta
Cyanidium
Porphyra
bas1 cpeB infB minD pbsA psbX rps20
hisH minD
pgmA rpl9 rps1 syfB syh upp
chlB chlL cpeA dsbD fabH fdx moeB
clpP ftsW psbM rbcLg
cystA cystT infA ndhA-K rps15
Glauco-cystophyta
Cyanophora
atpI cemA minD odpB
rne rpl23 rpl32
bioY crtE groES hemA mntA mntB nadA rbcSg
accA accB argB bas1 carA clpC cpcG cpeA cpeB dnaB dfr dsbD fabH fdx ftrB ftsH
glnB gltB ilvB ilvH infB infC moeB nblA ntcA odpA pbsA petJ pgmA psaD psaK psaL rbcLr
rbcSr rpl4 rpl9 rpl13 rpl24 rpl27 rpl29 rpl31 rps1 secA syfB syh thiG trpA trxA tsf upp
acpP apcA apcB apcD apcE apcF atpD atpG cpcA cpcB dnaK groEL hisH petF petM preA psaE psaF
psbV psbW psbX rbcR rpl1 rpl3 rpl6 rpl11 rpl18 rpl28 rpl34 rpl35 rps5 rps6 rps10 rps13 rps17 rps20 secY trpG
> 90% of genes lost
Primary endosymbiosis
Ancestral photosynthetic prokaryote
Chlorophyta
Chlorella
Nephroselmis
Mesostigma
psaM
ftsW ndhA-I ndhK
rpl22
accD
ndhJ odpB rpl33 rps15 rps16
rpl21
Euglenophyta
Euglena
accD ccsA cemA chlB chlL chlN clpP
cysA cysT ftsW infA minD ndhA-I ndhK
psbM petA petD petL psaI rne rpl19 rpoA
Secondary endosymbiosis
Streptophyta
Marchantia
rps16
cysA, cysT
rpl21, ndhA-K
Pinus
cysA, cysT,
rpl21
chlB, L, N, psaM
Nicotiana
accD
Oryza
Zea
chlI ftsW minD odpB rne rpl5 rpl12 rpl19 rps9 tufA

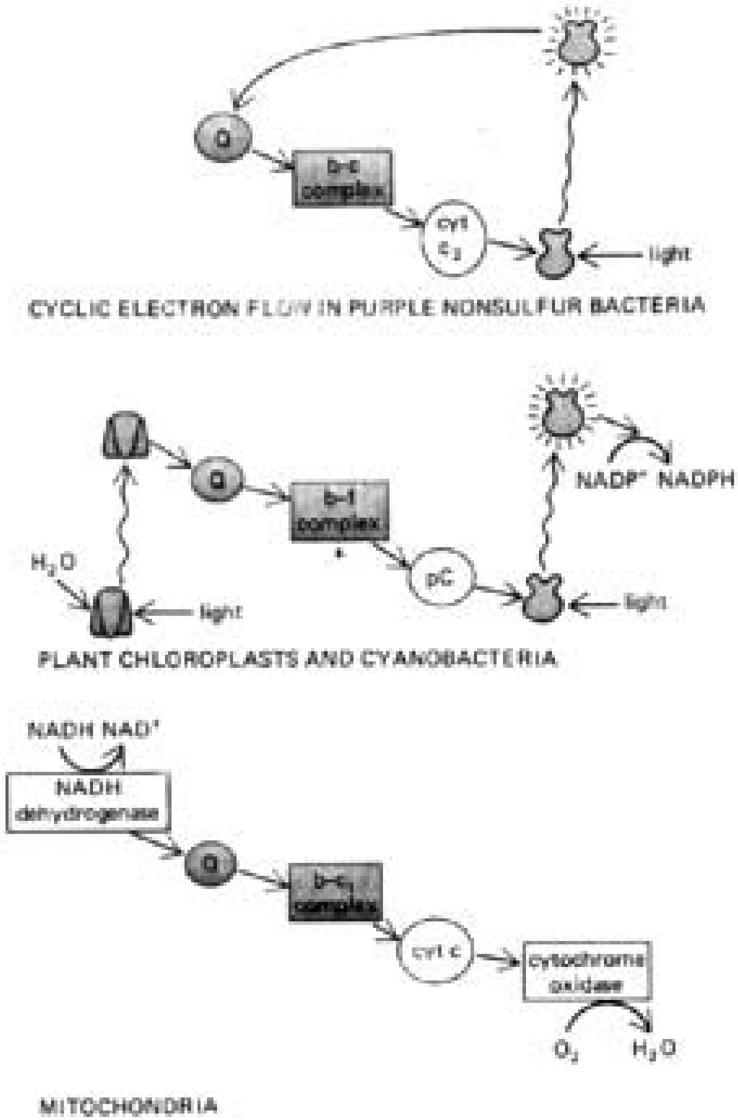
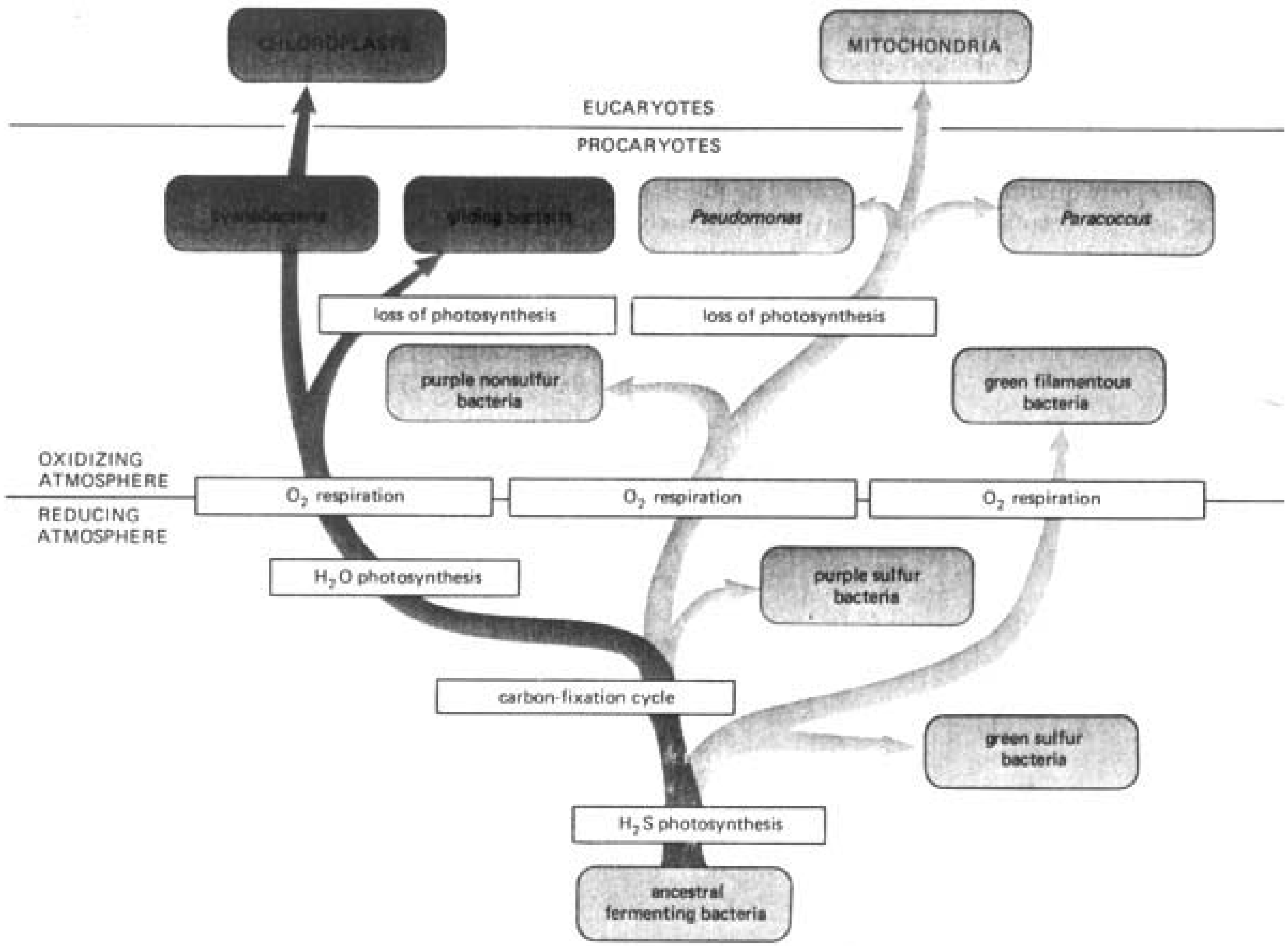


Figure 9–59 Bacteria, chloroplasts, and mitochondria all contain an electron-transport complex that closely resembles the b-c_1 complex of mitochondria. The complexes all accept electrons from a ubiquinonelike carrier (here designated as Q) and pump protons across their respective membranes. They are assumed to be evolutionarily related.

chloroplasts today



The codon wheel